LATERAL TRANSFER RETROREFLECTOR ASSEMBLY
AND METHOD OF ASSEMBLING THE SAME

BACKGROUND OF THE INVENTION

This invention relates to the field of retroreflectors, and more particularly, to lateral transfer retroreflectors.

Retroreflectors generally have the property of causing incident and reflected light rays to travel along parallel paths. To achieve this parallelism, a retroreflector normally consists of three optically flat reflecting surfaces, each reflecting surface positioned at a right angle to each of the other reflecting surfaces. Any departure of the reflecting surfaces from their perpendicular orientation will cause the incident and reflected light rays to depart from parallel.

Retroreflectors lose accuracy when they are exposed to external stresses. Examples of such external stresses are mass, thermal expansion or contraction of the substrate material from which the retroreflector is made, or deflection caused by curing of the adhesives which join members of the retroreflector.

Retroreflectors, and lateral transfer retroreflectors (which translate the reflected beam some calculated distance from the incident light beam), are old in the art. Examples of prior art retroreflectors and lateral transfer retroreflectors are:

U.S. Pat. No. 3,977,765 to Morton S. Lipkins, which disclosed a retroreflector mounted to a support structure through means of applying an adhesive into the joints formed between joined members of the retroreflector and to a flat surface of the support structure.

U.S. Pat. No. 4,065,204, also to Morton S. Lipkins, which disclosed a lateral transfer retroreflector consisting of a base, a roof reflector having two reflecting plates and a third reflector. The base acts as an extension of the third reflector by attaching the third reflector to the roof reflector in the manner known to retroreflectors to produce the lateral transfer retroreflector construction.

U.S. Pat. No. 5,024,514 to Zvi Bleier and Morton S. Lipkins, which discloses a lateral transfer retroreflector having a tubular member, a roof mirror and a mirror panel. Both the roof mirror and mirror panel are attached to the tubular member by use of three co-planar mounting pads.

U.S. Pat. No. 5,361,171, also to Zvi Bleier, which discloses a lateral transfer

retroreflector having a fixed-length tubular member, a roof mirror secured within a channel portion extending from an end of the tubular member and a mirror panel attached to the tubular member at the opposite end from the roof mirror and roof mirror panel.

It would be desirable to provide a high-accuracy lateral transfer retroreflector that is off-the-shelf adjustable as to the displaced length between the mirror panel and the roof mirror and also having a less temperature-deviant assembly and mounting of the roof mirror and mirror panel.

SUMMARY OF THE INVENTION

In accordance with the invention, an improved lateral transfer retroreflector assembly is provided. The lateral transfer retroreflector assembly of the invention is comprised of three separate, attached segments. A first segment comprising a mirror panel housing, a second segment comprising a roof mirror housing, and a third segment comprising a connecting member between the two housings.

The mirror panel housing will have mounted thereto a mirror panel. The roof mirror housing will have mounted thereto a roof mirror assembly, and the connecting member will be mounted between the mirror panel housing and the roof mirror housing. In addition, based upon the mounting together of the three separate segments, the connecting member will have the ability of being an off-the-shelf member that is selectively able to be cut to a particular length dimension based upon customer specifications, thereby allowing for customized creation of lateral transfer retroreflectors, but at a time and cost savings to the customer.

In addition, the roof mirror assembly and the mirror panel mounting are kinematic structures that are also improvements over earlier constructions. In particular, the roof mirror assembly of the subject invention has at least a pair of mounting members that act also as back supports and are located substantially at opposite ends of the roof mirror. The manner of attachment of the mounting members to the back portions of the mirror panels making up the roof mirror assembly, is such that expansion and contraction of the reflective surfaces of the mirror panels of the roof mirror assembly will only be in a direction substantially perpendicular to the direction of the roof angle axis. Deflection in this direction does not cause displacement (error), of the transmitted light beam traveling through the

lateral transfer retroreflector, and therefore such a mounting system is advantageous. Similarly, the mounting of the mirror panel to the mirror panel housing by means of substantially 45° chamfered edges, insures that the forces exerted by thermal expansion or contraction of the bonding material situated along those chamfered edges, will have a canceling effect, and not deflect the reflective surface of the mirror panel.

Accordingly, it is an object of the present invention to provide an improved lateral transfer retroreflector assembly.

Still another object of the invention is to provide a lateral transfer retroreflector assembly having a component construction capable of, allowing for off-the-shelf customization for different customer needs based upon differing customer specifications.

Yet a further object of the invention is to provide a lateral transfer retroreflector assembly having a roof mirror assembly construction and mounting such that deformations in the reflective surfaces of the mirror panels of the roof mirror assembly due to thermal expansion/contraction are minimized in the direction of the roof angle axis.

A still further object of the invention is to provide a lateral transfer retroreflector assembly, wherein the deflective forces exerted on the mirror panel by thermal expansion or contraction of the joint bonding the mirror panel to the mirror panel housing, are minimized.

Other objects of the invention will in part be obvious and will in part be apparent from the following description taken in association with the figures.

The invention accordingly comprises an assembly possessing the features, properties and relation of components which will be exemplified in the products hereinafter described, and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference is made to the following description taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a lateral transfer retroreflector assembly made in accordance with the invention;

FIG. 2 is a cross-sectional view taken along line 2-2 of **FIG 1**;

FIG. 3 is a perspective view of the mirror panel of the invention;

FIG. 4 is a left side elevational view of the mirror panel housing of the invention;

FIG. 4A is a partial prespective view of the mounting pad of member 26 of the mirror panel housing;

FIG. 4B is a partial perspective view of the mounting pad of member 24 of the mirror panel housing;

FIG. 5 is a right side elevational view of the mirror panel housing;

FIG. 6 is a cross-sectional view taken along line 6-6 of **FIG. 5**;

FIG. 7 is a left side elevational view of the mirror panel housing;

FIG. 8 is a cross-sectional view taken along line 8-8 of **FIG. 7**;

FIG. 9 is a perspective view of the roof mirror assembly of the subject invention;

FIG. 10 is an elevational view of one end of the roof mirror assembly of **FIG. 9**;

FIG. 11 is an elevational view of the other end of the roof mirror assembly of **FIG. 9**;

FIG. 12 is a bottom plan view of the roof mirror assembly of **FIG. 9**; and

FIG. 13 is a perspective view of a second embodiment of the roof mirror assembly of the subject invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to **FIG. 1**, a lateral transfer retroreflector assembly made in accordance with the invention and generally designated at **10**, is illustrated. Lateral Transfer Retroreflector ("LTR") **10** comprises three components; those being a mirror panel housing **20**, a roof mirror assembly housing **60** and a connecting member **90**.

As seen in **FIGs. 1** and **4**, mirror panel housing **20** is comprised of first and second side members **24** and **26**, as well as receiving member **28**, for receiving connecting member **90**. Housing **20** can also include member **30**, to lend extra stability to the structure, as well as aperture receiving member **22**, having aperture **32** extending therethrough. Aperture **32** can be of any geometric configuration, the preferred configurations being in the circle and square families. Aperture **32** has a first end **33** and a second end **35**, the distance between which will help dictate the inside diameter of connecting member **90**. It is to be understood herein that member **90** does not have to be circular in cross section, but could be of other shapes; particularly square. However, since light beams to be passed through LTR **10** are normally themselves circular in cross section, the preferred embodiment shown in the figures and discussed herein, will regard a circular aperture **32** and a circular tubular member **90**.

Continuing with the above discussion, the dimensional congruity between the size of aperture **32** and the cross sectional diameter of member **90** will insure that a light beam passing through LTR **10** will propagate through member **90** very close to the inside surface of member **90** as the beam approaches either of ends **33** or **35** of aperture **32**.

Turning now to **FIG 3**, mirror panel **34** to be used with LTR **10** is shown. Mirror panel **34** has a reflective surface **40**, and two chamfered edges **36** and **38**. As seen in **FIG 1**, mirror panel **34** is adhered to mirror panel housing **20** in such a manner as to be oriented with its reflective surface **40** below, and in reflective relation with, aperture **32** and member **90**. In practice, and as will be discussed in more detail below, the light beam, if it is entering LTR **10** through aperture **32**, will then reflect off of reflective surface **40** of mirror panel **34**, and propagate through member **90** into roof mirror assembly housing **60**, where it will reflect off of reflective surfaces **104** and **114** of roof mirror assembly **100** to propagate back toward the source of the beam, in a direction substantially parallel to the beam's incident direction, but at a displaced distance, substantially based upon the length of member **90**.

Continuing with **FIGs 3-8**, it is seen that mirror panel **34** is adhered at three contact surfaces to corresponding mounting pads **21, 23**, and **25** of edge portions **27** and **29** of first and second side members **24** and **26**, respectively. In particular, edge portions of **27** and **29**, and their corresponding mounting pads **21**, **23** and **25**, onto which mirror panel **34** is adhered, are themselves chamfered, as is best seen in **FIGs 4A and 4B**. The construction and mounting of mirror panel **34** of the subject invention is different to that of the prior art in U.S. Patent Nos. 5,024,514 and 5,361,171 (discussed earlier herein), in that the subject connection between mirror panel **34** and mirror panel housing **20** is chamfered surface to chamfered surface, as opposed to the prior art disclosure of mounting pads oriented perpendicularly to the reflective surface. What is similar, however, between the subject connection of mirror panel **34**, and the prior art connections, is the adhesion of mirror panel **34** to mirror panel housing **20** at only three distinct areas; two areas along chamfered surface **38** and only one area along chamfered surface **36**. The use of the matching chamfered surfaces **36/38** and **21/23 and 25** helps to reduce the distortional effect of the connection of mirror panel **34** to mirror panel housing **20**, as well as to help reduce stresses caused by thermal expansion/contraction, as the substantially 45° of the chamfers insures that such distortional forces do not distort rereflective surface **40** in a way to effect the orientation of

the beam passing through LTR **10**.

Specifically, LTR **10** of the present invention is a highly accurate instrument which can be used in such precise fields as surveying, military and aerospace applications, to name a few. It is usually necessary that instruments used in these areas meet very specific stress and dimensional specifications, and therefore the manner of construction of LTR **10** with respect to joining parts thereof together, and the length and depth dimensions of LTR **10**, are important. Accordingly, as will be discussed in more detail below, although lateral transfer retroreflectors are old in the art, the particular manners in which mirror panel **34** and roof mirror assembly **100** are made and mounted to their respective housings, will impact the durability and dimensional integrity of LTR **10**.

Turning now to a discussion of roof mirror assembly **100**, this assembly is best seen in **FIGs 9-12**. Roof mirror assembly **100** comprises a pair of mirror panels **102** and **112**, and a pair of mounting blocks **140** and **160**.

Mirror panels **102** and **112** have reflective surfaces **104** and **114**, respectively, which reflective surfaces are in reflective relation with reflective surface **40** of mirror panel **34**, as well as member **90** and aperture **32**. In particular, reflective surface **104** is substantially perpendicularly oriented to reflective surface **114**, and reflective surface **40** is itself oriented substantially perpendicularly to both reflective surfaces **104** and **114**. This mutually perpendicular orientation of the three reflective surfaces of LTR **10** essentially duplicates the construction of a standard Hollow™ retroreflector as is known in the art. Referring to **FIGs 9-11**, mirror panels **102** and **112** are seen to be adhered together at miter joint **110**. In order to create miter joint **110**, the attachment surfaces of mirror panels **102** and **112** which are joined together to create miter joint **110**, are at substantially **45** degree angles to reflective surfaces **104** and **114**, so as to create the perpendicularity between the reflective surfaces upon creation of miter joint **110,** and the associated reduction of distortive forces, as earlier discussed.

Continuing with a discussion of **FIGs 9-11**, it is seen that connected together panels **102** and **112** are finally formed into a secure roof mirror assembly through the mounting of back surfaces of panels **102** and **104** to portions of surfaces **142** and **162** of mounting blocks **140** and **160**. In so mounting panels **102** and **104** to blocks **140** and **160**, air gaps **150, 152, 154** and **156** are created between surfaces of mounting blocks **140** and **160** and surfaces **106**

and **126** of panel **102**, and surfaces **116** and **136** of panel **112** (see **FIGs 10** and **11**).

As is further seen in **FIGs 10** and **11**, the back surfaces of panels **102** and **112** that are adhered to mounting blocks **140** and **160** as discussed above, are surfaces **108** and **128** for panel **102**, and surfaces **118** and **138** for panel **112**. In construction, surfaces **108/128** and **118/138** are all substantially perpendicular in orientation to miter joint **110**. Such a construction ensures that any substantial distortional effects due to thermal expansion/contraction of panels **102** and **112** and/or block **140** and **160** will be in a direction substantially perpendicular to a longitudal axis for roof mirror assembly **100**; i.e., perpendicular to the planes of reflective surfaces **104** and **114**.

Turning again to **FIG 1**, it is seen that roof mirror assembly **100** is secured to roof mirror assembly housing **60** by way of connection between bottom surfaces **141** and **161** of blocks **140** and **160** to member **70** of housing **60**. Such a secure connection of roof mirror assembly **100** to housing **60** assists and strengthens the durability of LTR **10**.

Regarding connecting member **90**, as has been stated, this member can be cut from an off-the-shelf member of standard construction and length. Such an off-the-shelf retro-fit of connecting member **90** allows one to stock separate quantities of housings **20** and **60**, and member **90**, for construction of an LTR **10** to meet any customer specifications, in a quick and cost affective manner.

Turning now to a discussion of **FIG 13**, a second embodiment of the inventive roof mirror assembly **100** is shown at **300**. Assembly **300** is constructed identically to that of assembly **100**, accept for the addition of back plate member **302**, adhered below mounting blocks **340** and **360**, to surfaces **341** and **361** (not shown).

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained, and, since certain changes may be made in the above constructions without departing from the spirit and scope of the invention, it is intended that all matter contained in the above description and shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language might be said to fall therebetween.